

## Potential impact of climate change on fisheries and aquaculture in Nigeria

Ipinjolu, J. K. / Magawata, I. / Shinkafi, B. A.

### Abstract

*Climate change will have significant impacts on Nigeria's freshwater and marine aquatic systems, and hence on the country's fisheries and aquaculture. Fisheries and aquaculture are highly vulnerable to changes in weather pattern, and the impacts, which could be negative or positive, will vary from the coastal areas to the drier northern parts of the country. Elevated water temperatures will affect fish physiological processes, thereby affecting spawning, survival of the juveniles, recruit into the exploitable phase of population, population size, production and yield. The impacts of increased flooding of the freshwater bodies will be negative through erosion of watershed, destruction of fish feeding and breeding habitats, decrease in primary productivity and alteration of the normal resilience of the aquatic systems, or positive in expansion of aquatic habitats for primary and fish productions especially during the dry season. Drought will exacerbate draw down of the lakes and reservoirs, and insufficient flow in the river basins for spawning and primary production thereby affecting fish production. Rise in the water level of the Atlantic ocean will lead to intrusion of more salty water into the river delta areas, and inundation of the coastal low-lying areas, thus affecting distribution of both the freshwater and marine fishes as a result of changes in the physical and chemical properties of the waters. The impacts will ultimately affect fish population, production and supply, thereby affecting the livelihoods of over 26 million people engaged in the primary and secondary sectors of the fisheries industry, as well as food security of the country. The adaptation and mitigation strategies will be based on the peculiar characteristics and interactions of fisheries and aquaculture within the framework of feasible policy instruments. Strategies and policy measures need to be evolved to combat the observable and projected impacts of climate change on fisheries and aquaculture, in order to protect the livelihoods of the fishing communities and food security.*

**Keywords:** Climate change, fisheries, aquaculture; Impacts, mitigation, food security.

### Introduction

Climate is dynamic in the sense that analysis of some relevant climate elements revealed that natural forces have enforced change over centuries (Cunningham and Cunningham, 2004), and such changes are inevitable natural occurrences. However, anthropogenic factors have exacerbated climate change in recent times, and the impacts on socioeconomic and livelihoods of people, as well as the mitigation and adaptive measures, are current issues that have attained global dimension.

The indications of global climate change as revealed in several studies include increased temperature, estimated at nearly 0.2°C per decade since 1980 (Osborn, 2010), increased precipitation in some areas and a decrease in others and rise in ocean level (Cunningham and Cunningham, 2004). Climate change and the impacts in Nigeria have attracted the attention of the local scientists and international bodies. Some of the reports and publications with focus on the country include those of Okali (2004), Gwary (2005, 2010), Ajani (2009), BNRCC (2007), DFID (2008) and FAO (2007). Gwary (2010) reviewed the report of DFID (2008) on the predicted changes in temperature and precipitation in the country from 2010 – 2050 (Table 1).

There are some empirical evidences on the impacts of changes in weather pattern on fisheries at the regional and global levels which could provide basis for assessment of the potential impacts of climate change on fisheries and aquaculture in Nigeria. Recent natural and man-induced occurrences in the country, such as drought, desertification and floods have links with climate shift. Based on critical analysis of these evidences and events, this paper examined the potential impacts of climate change on fisheries, aquaculture, food security and livelihoods in Nigeria and research needs for possible pro-active or mitigation measures.



## Nigeria's Fisheries Resources and Exploitation In a Changing Climate

Nigeria is a maritime country with tremendous aquatic and fisheries resources that makes significant contributions to livelihood, food security and the overall economy of the nation. The country's freshwater and marine fisheries resources are enormous, and offered tremendous opportunities for fish production through capture and culture fisheries (Table 2). The freshwater bodies comprised of seasonal and perennial rivers, lakes, reservoirs and dams, estimated at about 14 million hectares. The coastal waters, comprising of the creeks, lagoons and estuaries, have been estimated at about 37,934km<sup>2</sup>. As with other maritime countries, the country has jurisdiction over the physical, chemical and biological resources within a distance of 320km nautical kilometers (853km<sup>2</sup>) into the Atlantic Ocean.

Exploitation of the fisheries resources in the freshwater and coastal water bodies is largely by artisanal (small-scale) fisheries, employing simple fishing gear and equipment. This sub-sector employs over 8 million fishermen, another 18 million people engage in fish processing, distribution and marketing and accounts for well over 80% of the total annual domestic fish production (FDF, 2008). The industrial sub-sector is based largely on fishing in the Atlantic Ocean. The country's portion of the Atlantic is not an isolated entity; therefore changes in the physical, chemical and biological properties of this ocean arising from climate change will also affect the country. This sub-sector, which is mainly in the hands of large-scale investors, contributes about 4% of the annual domestic fish production.

Fish farming in the country is based mainly on the culture of few species in the inland (freshwater) and coastal brackish water areas (lower elevation in the lagoons, creeks and estuaries). The inland fish farms are fed by water from rainfall, rivers reservoirs, tube-well or boreholes, in concrete and earthen ponds. This sub-sector employs about 300,000 fish farmers and accounted for about 14 % of the country's total domestic fish production in 2007 (FDF, 2008).

Table 1: Projected increases in temperature and precipitation (mm) in Nigeria.

Scenario	Year		
	2010	2020	2050
<b>Temperature</b>			
Low	0.4	0.5	1.0
Best	0.7	0.8	1.8
High	0.9	1.3	3.2
<b>Precipitation</b>			
Low	3	4	8
Best	5	6	14
High	7	9	19

DFID (2008) in Gwary (2010)

Table 2: Nigeria fisheries resources and production.

Parameter	Magnitude
<b>Land and Water</b>	
Area	923,768km <sup>2</sup>
Length of Coastline	37,934km <sup>2</sup>
Exclusive Economic Zone	853km
Inland Waters	14m ha
Available land for Aquaculture	1.7m ha
<b>Fish Resource Category</b>	
<b>Estimated yield/annum(mt)</b>	
<b>Finfish</b>	
Coastal resources	142,000
Inshore resources	16,620
Offshore Demersal resources	6,370
Tuna and Pelagic resources	15,000
<b>Shellfish</b>	
Coastal Artisanal	48,000
Industrial	3,760
<b>Fresh Water Resources:</b>	
Rivers/Flood plain	226,550
Lake Chad	160,000
Kainji Lake	30,000
<b>Aquaculture</b>	<b>2.5m</b>

Source: Compiled from FDF (2008)



### Climate Change Impact on Fisheries and Aquaculture

As noted by FAO (2008), climate change impact is expected to cut across ecosystems, societies and economics, livelihoods and food supplies, and the West and Central African countries are most vulnerable due to ecological and social factors (World-Fish Centre, 2010). The effects could be negative or positive depending on the severity and extremity of the shift in the climate elements. Fisheries is particularly vulnerable because aquatic habitats directly absorbed and stores part of the solar heat energy, most fish species are cold blooded and majority of the physico-chemical parameters, and hence the quality of water bodies, interact with the water temperature. Consequently, climate change will affect water supplies and the populations, the normal resiliency and productivity of aquatic ecosystems, livelihoods and food security. The specific impacts are examined in the following sections:

- **Effect on fish physiology and population:** Most freshwater and marine fishes are cold-blooded animals. Therefore, the body physiological and biochemical processes functions according to the dictates of the prevailing water temperature. Elevated temperatures positively alter the breathing rates, feed consumption, enzyme activities, oxygen consumption and feed metabolism (Smith, 1980), thereby affecting fish growth. The growth rate will determine how fast maturity size is attained, the fecundity, recruitment into the exploitable phase of the population and ultimately influence increase in population size. The population size determines the production achieved as well as yield, that is, the amount available for harvesting based on sustainable yield principles. Freshwater and marine fish populations are already threatened by pressure from human activities arising from over fishing and pollution, with resultant decline in quantity and quality. Mortality is high at the juvenile (larvae, fry and fingerlings) stage due to factors such as predation, competition and water quality and only small proportion survives to the adult stage. Increase in water temperature will exacerbate these situations with resultant decrease in fish population. Predictions on the short-term impact of increasing temperature is in limiting oxygen transport which could have significant impacts on aquaculture and result in changes in distribution and abundance of both marine and freshwater species (FAO, 2008).
- **Impacts on water flow:** It is projected that climate change will lead to a general increase in precipitation in Nigeria within the next 50 years (DFID, 2008). However, this increase will not be uniform across the country; as some areas experience floods, others will be greeted with drought (Gwary, 2010). The impact of increased flooding of the rivers, lakes and reservoirs will be positive or negative depending on the severity. The floods experienced in many parts of the Country in the rainy season of 2010 and the devastating effect is attributable to climate change, and there are indications that the country should prepare for hard times ahead. The Sokoto-Rima basin in the north-western part was one of the areas worst affected: communities living close to the river system were intimidated; lives were lost, livestock swept away; farmlands submerged and crops and economic trees dislodged; road networks destroyed; watershed and littoral zones of freshwater bodies aggressively eroded; productive fishing areas were lost; schools closed and socio-economic activities paralysed. The relics of this historical flood and huge economic loss should be explored to create awareness on the dangers of climate change and the need for mitigation and adaptive measures
- The impacts could also be positive. Increased rainfall and flooding will lead to inundation of adjacent land areas and this will be beneficial to fisheries. It will expand the littoral zones and increase the diversity of the ecotones for fish feeding, breeding and rearing of the juveniles. Erosion of littoral zones, siltation of breeding and feeding sites, displacement of fish to new habitats often caused by excessive floods are detrimental to fisheries.
- **Rise in the level of Atlantic Ocean:** Global warming is projected to cause rise in the ocean level as a result of thermal expansion of the ocean water and melting of glaciers (Cunningham and Cunningham, 2004). Rise in the level of the Atlantic ocean will cause intrusion of more saline water into the river deltas and inundation of the lower lying coastal areas. The former will lead to changes in the water physical and chemical characteristics, alter the ecology of the habitats and lead to upstream distribution of more euryhaline fishes into the river system. The stenohaline fishes, which are mostly oceanic species that withstands only small salinity range, will be distributed into the coastal waters. The change in the distribution pattern will affect the ecology of fishes and impact negatively on fish production. This will also have serious implications on the brackish and freshwater aquaculture in the coastal areas.
- **Impact on water quality and fish distribution:** The key water quality parameters such as dissolved oxygen are greatly influenced by water temperature because of the inverse relationship between the two. Higher temperatures reduce oxygen solubility in water, favour the survival of parasites and bacteria; these conditions will collectively reduce fish survival, affect the natural foods, growth and reproductive success of wild populations and aquaculture species (Halls, 2009).
- Climate change will impact on the diverse water bodies and threaten their capacity for sustainable fish production. Report by FAO (2004) indicated that African lakes will most likely witness elevated temperatures because the atmospheric temperature on the continent is higher than the global average while rainfall is predicted to decrease. The report also noted that the wetland and shallow rivers are more susceptible to temperature and precipitation changes. It is therefore projected that increased temperatures may lead to stronger, earlier and longer stratification of the lakes and reservoirs; limited or no seasonal turn over; greater deoxygenation of the bottom layers; thereby lowering primary productivity and influencing distribution of aquatic organisms. Studies have shown that tem-



perature is the most significant factor determining the stability of the ocean water because it exert greater influence on the water density than other factors such as salinity and depth. Therefore, variation in water temperature in the different parts of the Atlantic (ocean) water will lead to variation in the density, and this will affect distribution of organisms and fishing. Elevated ocean temperature will affect the distribution of stenothermal and eurythermal species, displacing them to habitats where survival, growth and reproduction may be at great risk.

- **Impacts on livelihoods of communities and food security:** Fish and aquaculture play important role in food security and livelihoods of people particularly in developing countries, but these roles are often unrecognized and undervalued. However, reports indicate that many fishing and coastal communities now live in precarious and vulnerable conditions because of overexploitation of their fishery resources, degradation of the aquatic habitats, poverty and rural under development (FAO, 2010). Those conditions are now exacerbated by the profound effects of climate change which, according to report by FAO (2010), is threatening inland fisheries across the world (90% of which are found in Africa and Asia) and fish farming (65% of which is also inland based), thereby putting at risk the food supply and livelihoods of the poor population. The fishing communities in Nigeria belong to the low income group. They depend on fishery resources that are already stressed due to long period of overfishing, and live in rural areas where basic social amenities and infrastructures are not in place.

Fisheries and aquaculture are vulnerable to climate change with profound impacts on the communities that depend on them. However, their vulnerability depends on the potential impact (sensitivity plus exposure) and the adaptive capacity of the systems, and African fisheries, including Nigeria, are more vulnerable due to ecological (semi-arid and coastal locations) and social (large dependence on fish for protein, low adaptive capacity, weak economies and low human development) factors (WorldFish Centre, 2007). In Nigeria, the livelihood of about 26 million people in fishing communities in coastal areas and their socio-cultural ties with lacustrine habitats, about 300,000 fish farmers, consumers that depend on fish for protein supply, and the present 4% contribution of the fisheries sub-sector to the agricultural sector's contribution of 40% to the GDP (FDF, 2008) will all be affected. Therefore, the impacts of climate change on the country's fisheries and aquaculture will affect fish production and supply, as well as the livelihoods of communities that depend on fishing and fish based enterprises, fish consumers and the food security of the country.

### Climate Change Adaptation And Mitigation In Fisheries And Aquaculture

Fisheries and aquaculture provide several opportunities for adaptation; but it is difficult to predict or model how the systems will respond to climate change. The response will depend mainly on the characteristics of the fisheries and the adaptive capability of the communities. However, the country need adaptive and mitigation strategies that will improve the management of the fisheries and aquaculture, protect the integrity of the aquatic ecosystems, respond to the opportunities and threats on livelihoods and food security and reduce greenhouse gas emissions (Joint policy brief of FAO and several agencies, 2009).

### Conclusion

There are increasing empirical evidences on the impact of climate change on fisheries and aquaculture with serious implications on the livelihoods of communities and food security in Nigeria. There are also some historical data to predict and model the pattern of shift in the climate elements in the country. However, assessing the impacts of the changes on the country's fisheries and aquaculture will still be based largely on observations, projections and experiences of other similar countries, due to lack of reliable quantitative data. It is therefore imperative to put in place the necessary structure to collect and maintain relevant data on climate change and the impact, possible responses of the fisheries and aquaculture systems, and feasible adaptive and mitigation measures. We can see and feel the impact of climate change, and several reports indicate that climate change will be unavoidable for the next century. Therefore, government need to adopt relevant policy measures for management of climate change and partner with the private sector to invest in adaptive and mitigation strategies to protect fish production, the livelihoods of the communities that depend on them and food security.

### REFERENCES

- Ajani, E.K. (2009). Climate change and aquaculture development in Nigeria: Experiences and adaptation strategies. In: Climate Change: Risks, Challenges and Discussions. *IOP Conf. Series: Earth and Environmental Science* 6, IOP Publishing Ltd.
- FDF (2008). Fishery Statistics of Nigeria. Fourth Edition. 1995 – 2007. *Federal Department of Fisheries, Abuja, Nigeria*, 49p.
- FMA and RD (2007). Ministerial Press Briefing (2006). *Federal Ministry of Agriculture and Rural Development (FMA & RD), Abuja, Nigeria*, 28p.
- FMA & WR (2008). Nigeria's National Food Security Programme at a Glance. *Federal Ministry of Agriculture and Water Resources, Abuja, Nigeria*, 14p.
- \_\_\_\_\_. (2008). Report of the FAO Expert Workshop on Climate Change: Implications for Fisheries and Aquaculture, Rome 7 – 9 April 2008. *FAO Fisheries Report*. No 870, 32p.
- \_\_\_\_\_. (2009). Fisheries and aquaculture multiple risks from climate change. *Food and Agriculture of the United Nations*. <http://www.fao.org/news/story/0/item/38060/code/en>. Accessed December 2010
- \_\_\_\_\_. ICES, WorldFish Centre, SDR and Others (2009). *Fisheries and Aquaculture in a Changing climate*. [http://www.unep.org/ecosystemmanagement/Portals/7/Documents/policy\\_brief\\_EM-mce-CC-Fisheries.pdf](http://www.unep.org/ecosystemmanagement/Portals/7/Documents/policy_brief_EM-mce-CC-Fisheries.pdf). Accessed December 2010.

- Gwary, D. M. (2010). Climate change adaptation and mitigation options for improving food security in Nigeria. *A lead paper presented at the 6<sup>th</sup> National Conference on Organic Agriculture, 22–24 November, 2010.* University of Maiduguri, Maiduguri, Nigeria. 18p.
- Halls, A. S. (2009). Addressing fisheries in the climate change and adaptation initiative. *Fisheries Research and Development in the Mekong Region*, 15(1).
- Osborn, L. (2010a). History of changes in the earth's temperatures. *Current Results News*. [www.currentresults.com/---facts/changes-in-earth-temperature.php](http://www.currentresults.com/---facts/changes-in-earth-temperature.php).
- . (2010b). Fish and seabirds starve in abnormal ocean conditions. [www.currentresults.com/climate\\_change/Ecology\\_Impacts/fish.php](http://www.currentresults.com/climate_change/Ecology_Impacts/fish.php).
- . (2010c). Rising Atlantic erodes waterfront and real estates. [www.currentresults.com/Climate\\_Change/---/rising-710231.php](http://www.currentresults.com/Climate_Change/---/rising-710231.php).
- Worldfish Centre (2007). Fisheries and aquaculture can provide solutions to cope with climate change. [www.worldfishcenter.org/resource\\_centre/CC\\_Threat\\_to\\_Fisheries1701-pdf](http://www.worldfishcenter.org/resource_centre/CC_Threat_to_Fisheries1701-pdf).